2011 Tornadoes
&
A Weather Ready Nation

Dr. Russell S. Schneider

Greg Carbin

NWS Storm Prediction Center

1 March 2012

"Where America's Weather and Climate Services Begin"

Each Year: About **1,300 tornadoes** touch down across the United States causing an estimated **$1.1 billion in damage** and over **80 deaths**

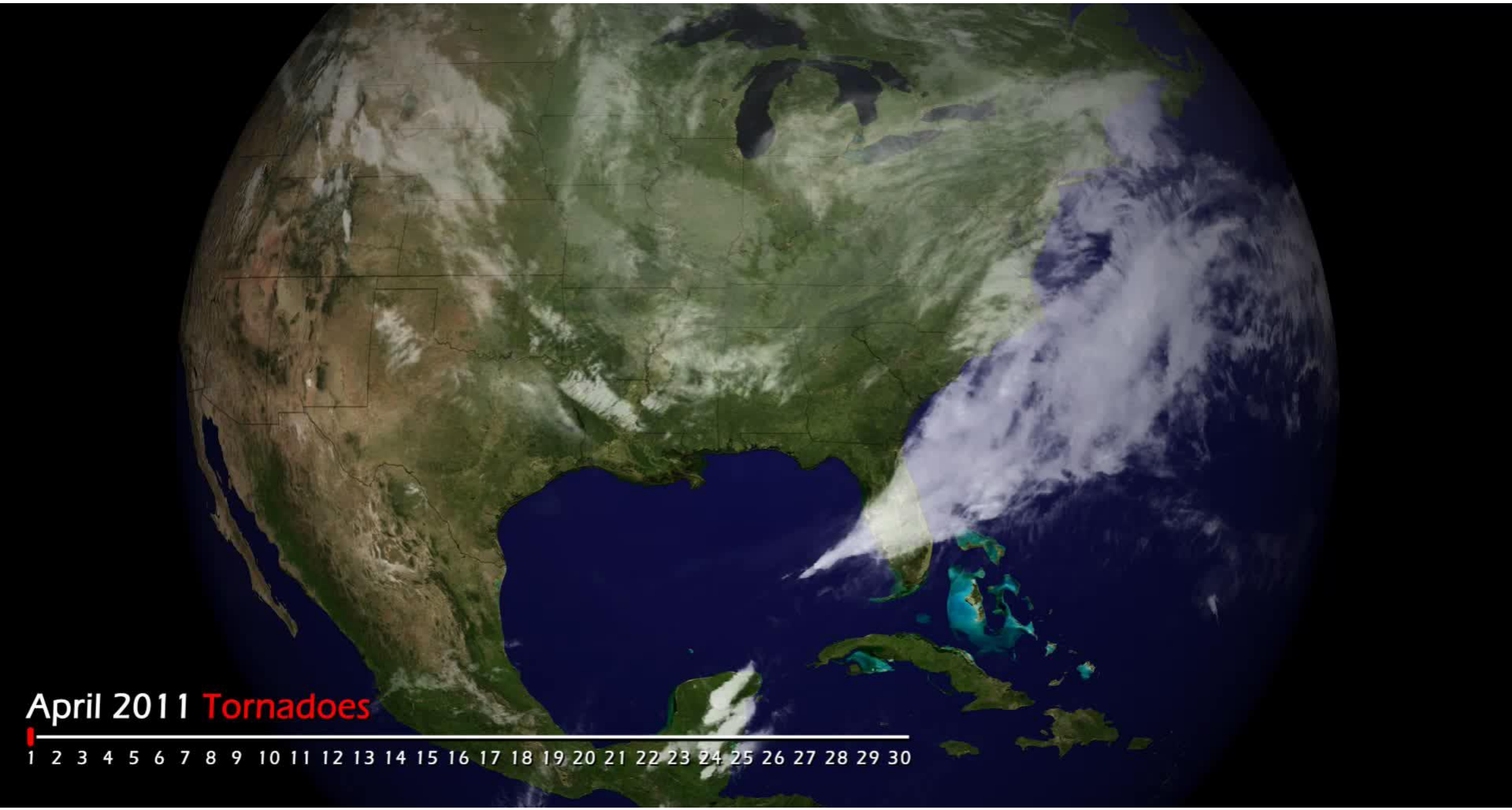
In 2011: About **1,700 tornadoes** have touched down across the United States causing an estimated **$20 billion in damage** and **550 deaths**

NOAA

Storm Prediction Center
Norman, Oklahoma

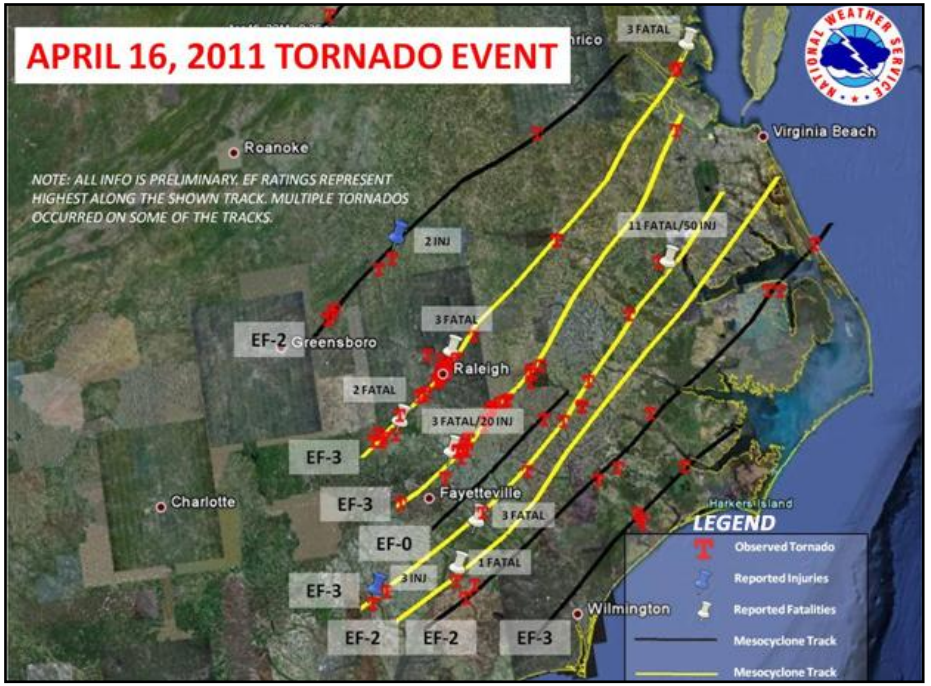
Record April Tornadoes: A Satellite Summary

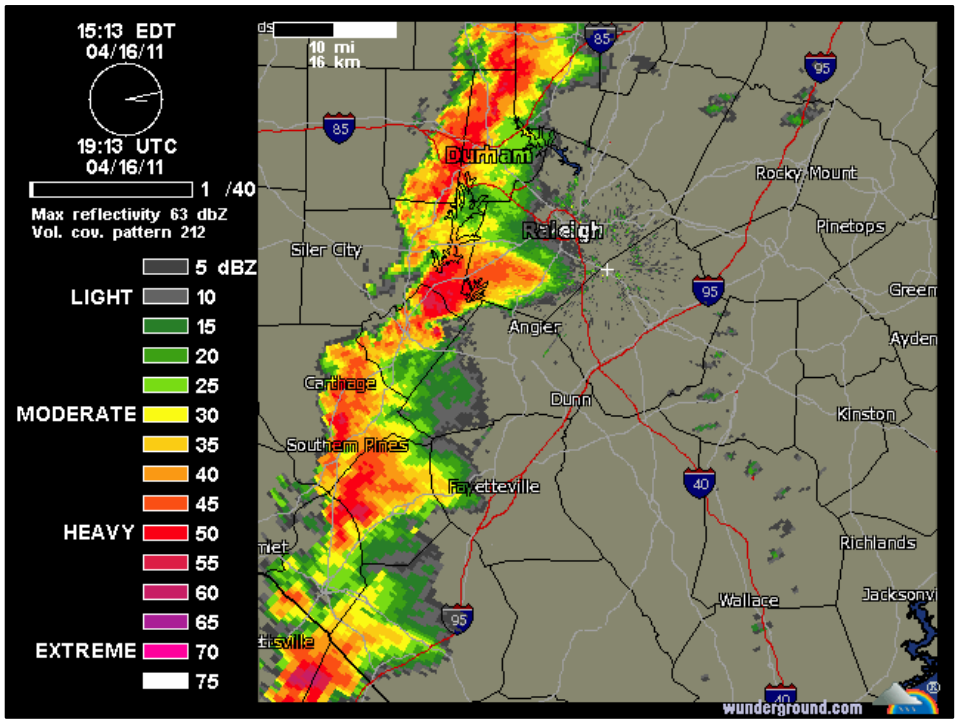
tornado reports appear as red dots



April 16, 2011

GA-MD-NC-PA-SC-VA: 56 tornadoes, 26 deaths, 480 inj., $412M



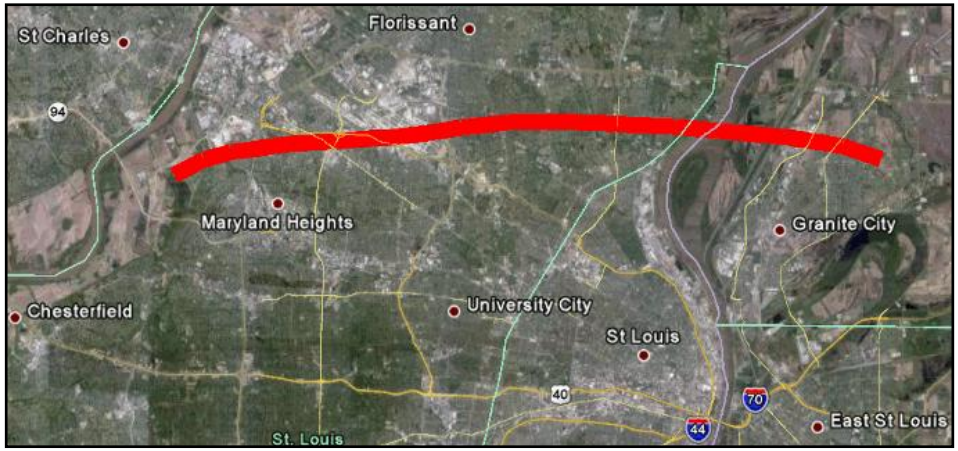


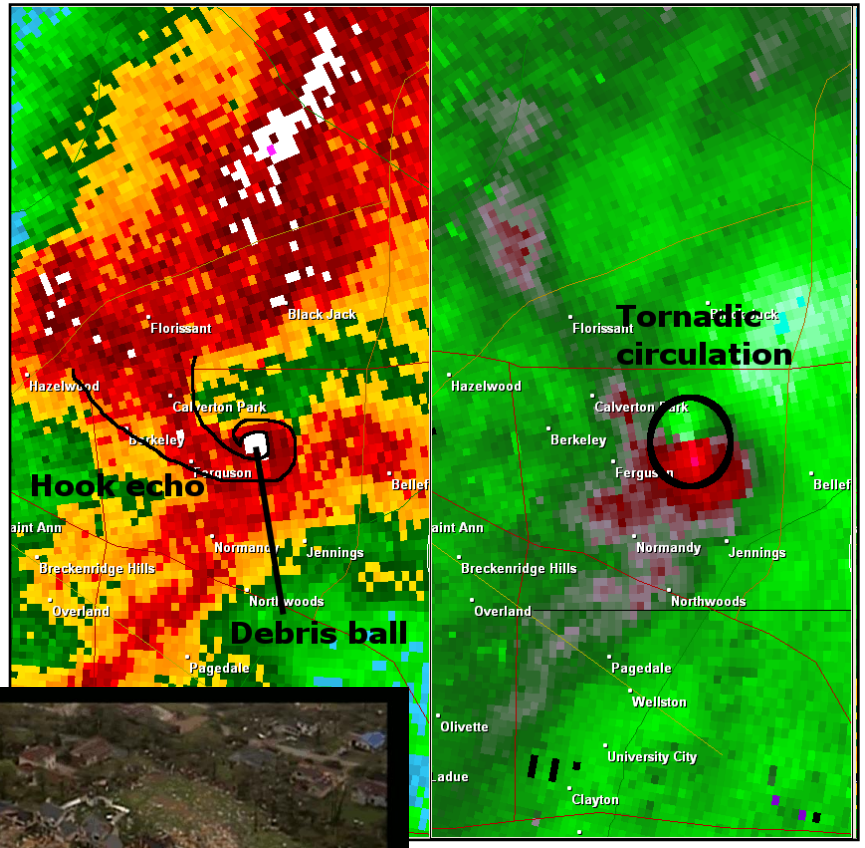
April 16, 2011

GA-MD-NC-PA-SC-VA: 56 tornadoes, 26 deaths, 480 inj., $412M

Good Friday EF4 Tornado – April 22, 2011

Strongest Tornado in St. Louis County in 44 Years. No Fatalities!



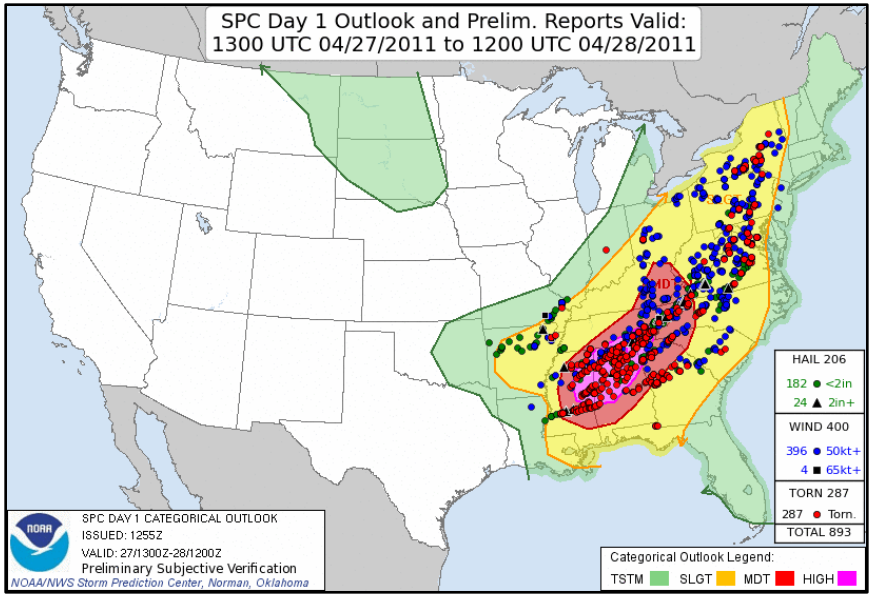


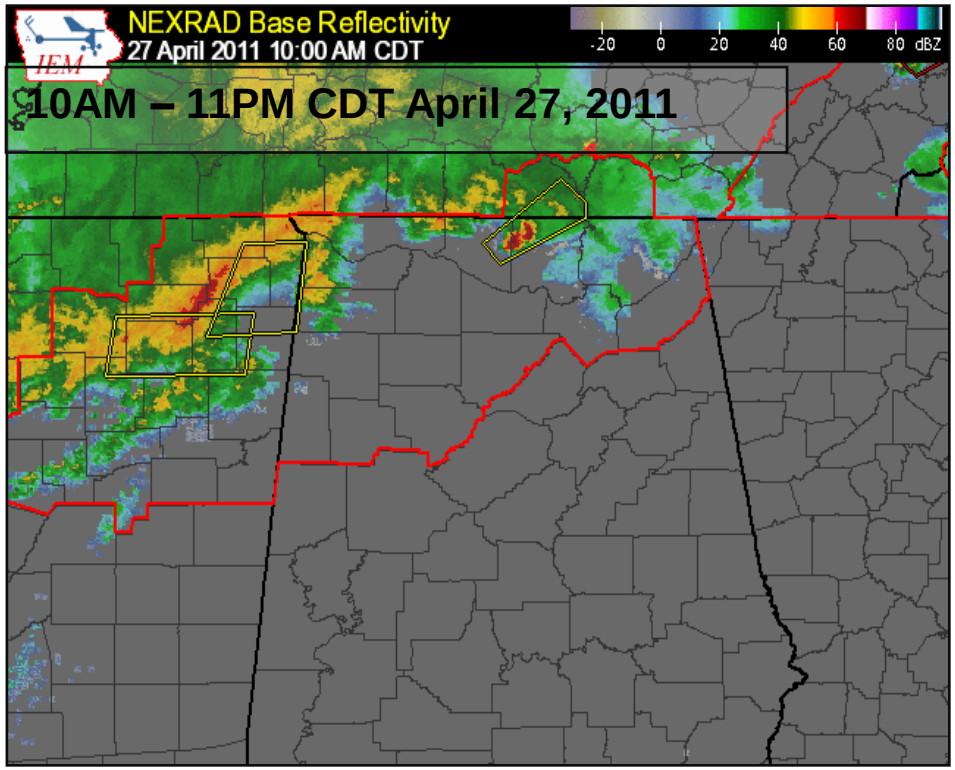
Storm Prediction Center
Norman, Oklahoma

Good Friday EF4 Tornado – April 22, 2011

Strongest Tornado in St. Louis County in 44 Years. No Fatalities!

27 April Deep South Super Outbreak





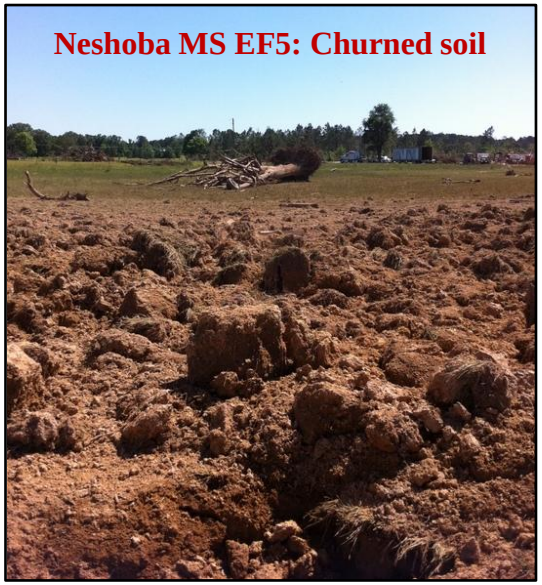
Tuscaloosa, AL (EF4, 64 deaths, 1500+ inj.) & Madison County, AL (EF5, 72 deaths, 145+ inj.)

Tuscaloosa, AL: EF4, 64 deaths, 1500+ inj.

Tuscaloosa, AL: EF4, 64 deaths, 1500+ inj.

Tuscaloosa, AL: EF4, 64 deaths, 1500+ inj.

Both Horrific & Incredible Impacts …



Storm Prediction Center
Norman, Oklahoma

2011: Joplin, MO

Joplin, MO (EF5, 158 deaths, 700+ inj.)

Joplin, Missouri Neighborhood: Before / After

Lower chance of survival from an EF5 outside of a safe room or underground shelter.

Joplin, Missouri “Big Box” Store: Before / After

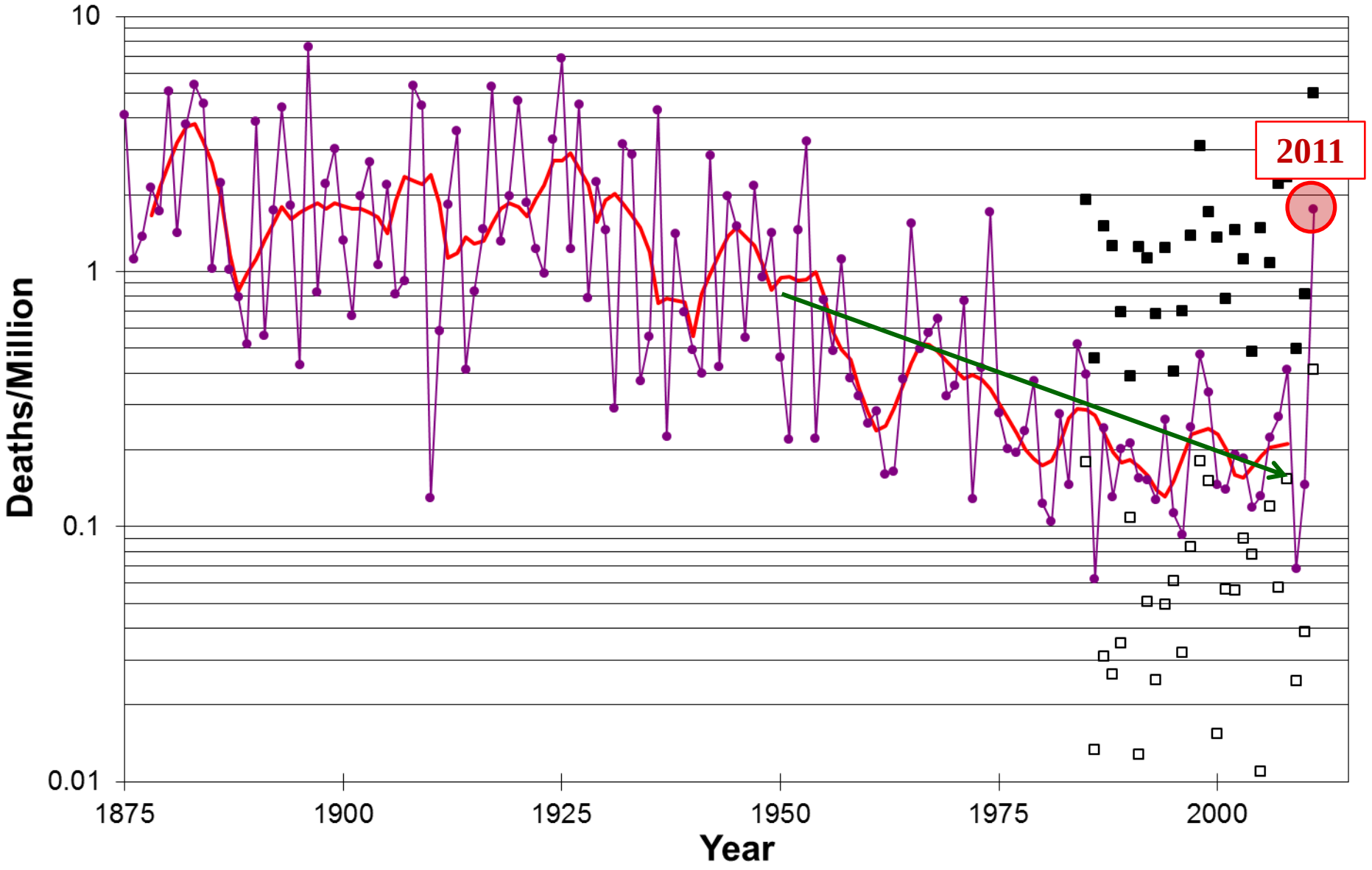
Open span roofing and poured concrete walls prove to be deadly “shelter” options.

Deadliest US Tornadoes

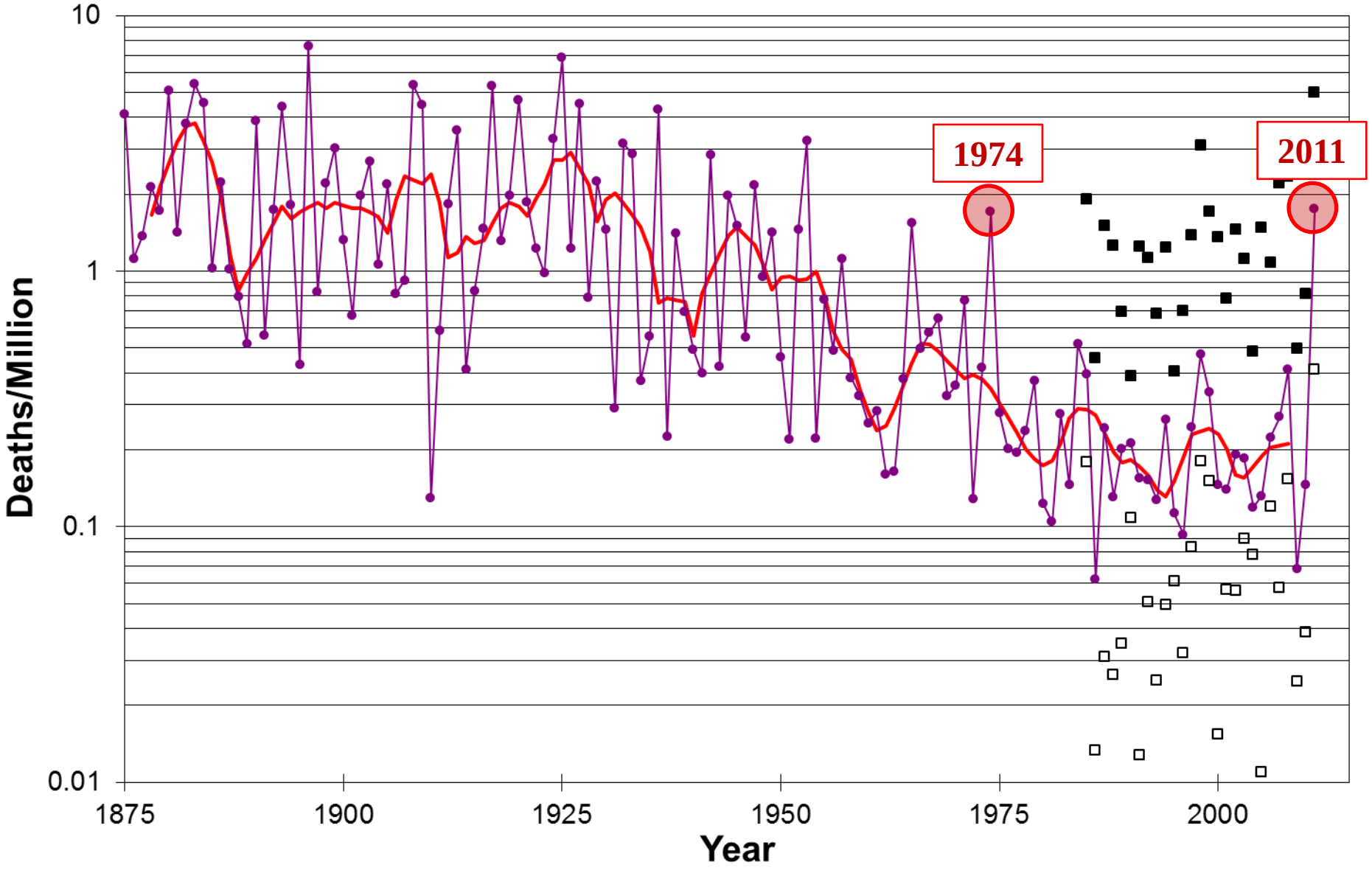
(Official NOAA-NWS Record: 1950 - present; Research by Grazulis: 1875-1949)

Date	Fatalities	Location
18 March 1925	**695**	**Tri-State Tornado (MO-IL-IN)**
06 May 1840	317	Natchez, MS
27 May 1896	255	St. Louis, MO
05 April 1936	216	Tupelo, MS
06 April 1936	203	Gainesville, GA (Work Day Morning)
09 April 1947	181	Woodward, OK
22 May 2011	**158**	**Joplin, MO**
24 April 1908	143	Amite, LA & Purvis, MS
12 June 1899	117	New Richmond, WI (Circus in Town)
08 June 1953	116	Flint, MI
11 May 1953	114	Waco, TX
18 May 1902	114	Goliad, TX

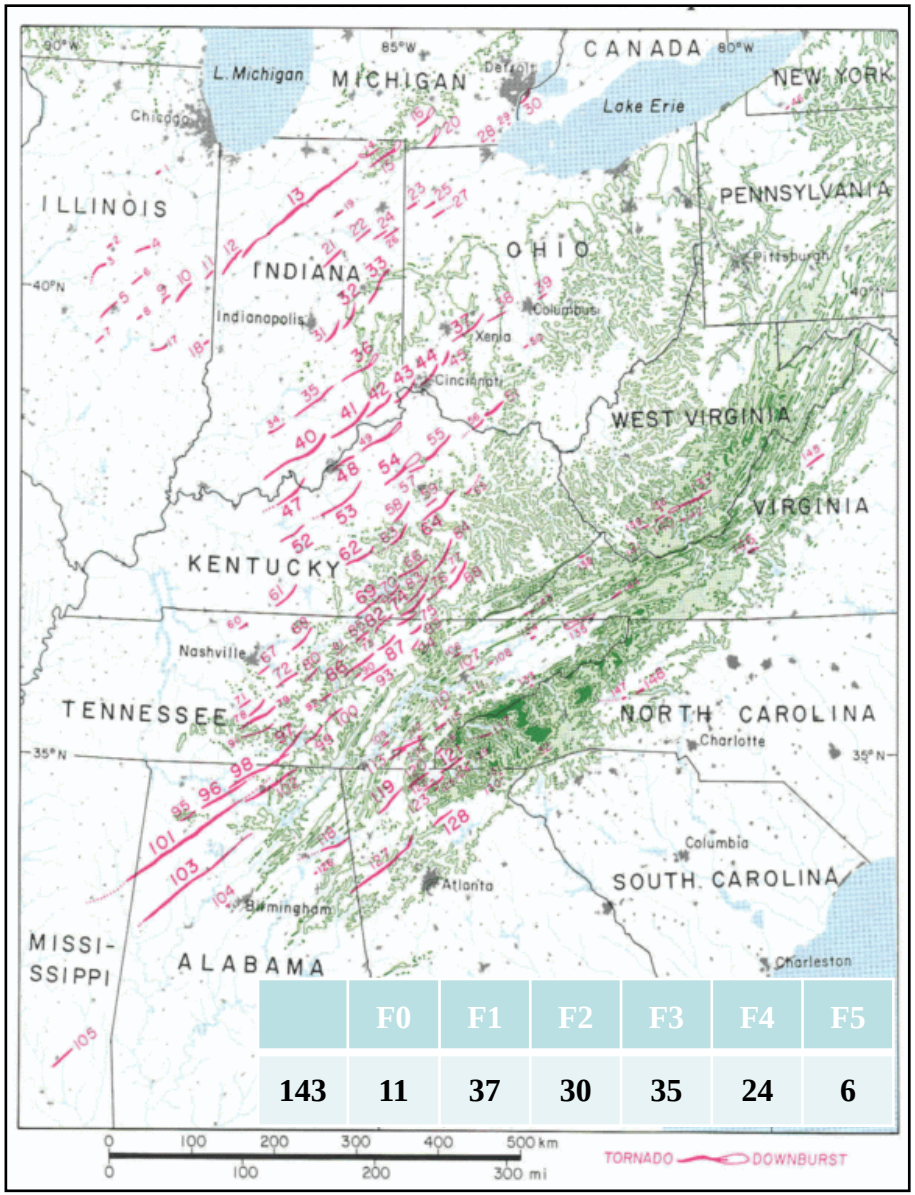
US Tornado Deaths per Million in Population



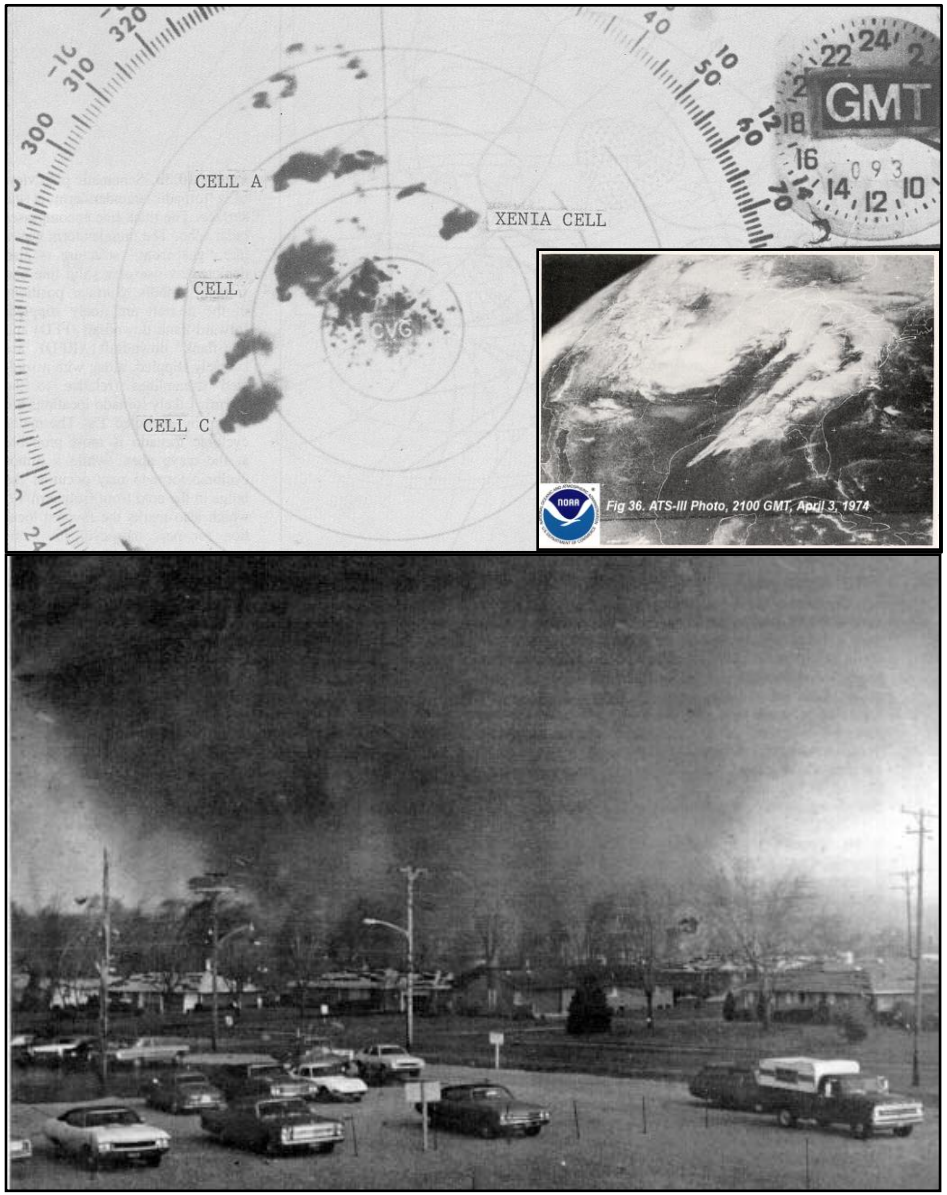
US Tornado Deaths per Million in Population



1974 - 366k: Super Outbreak

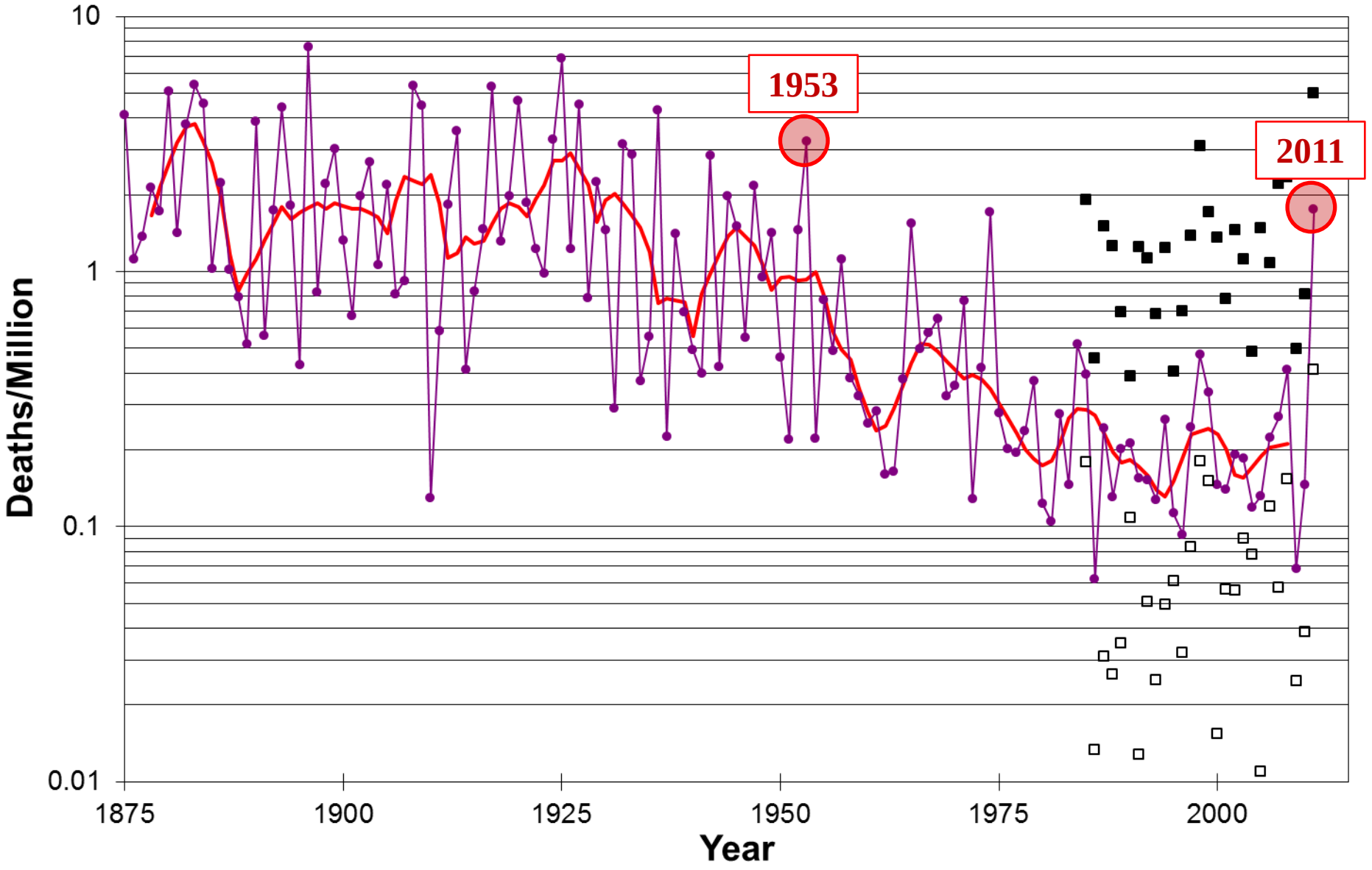


	F0	F1	F2	F3	F4	F5
143	11	37	30	35	24	6

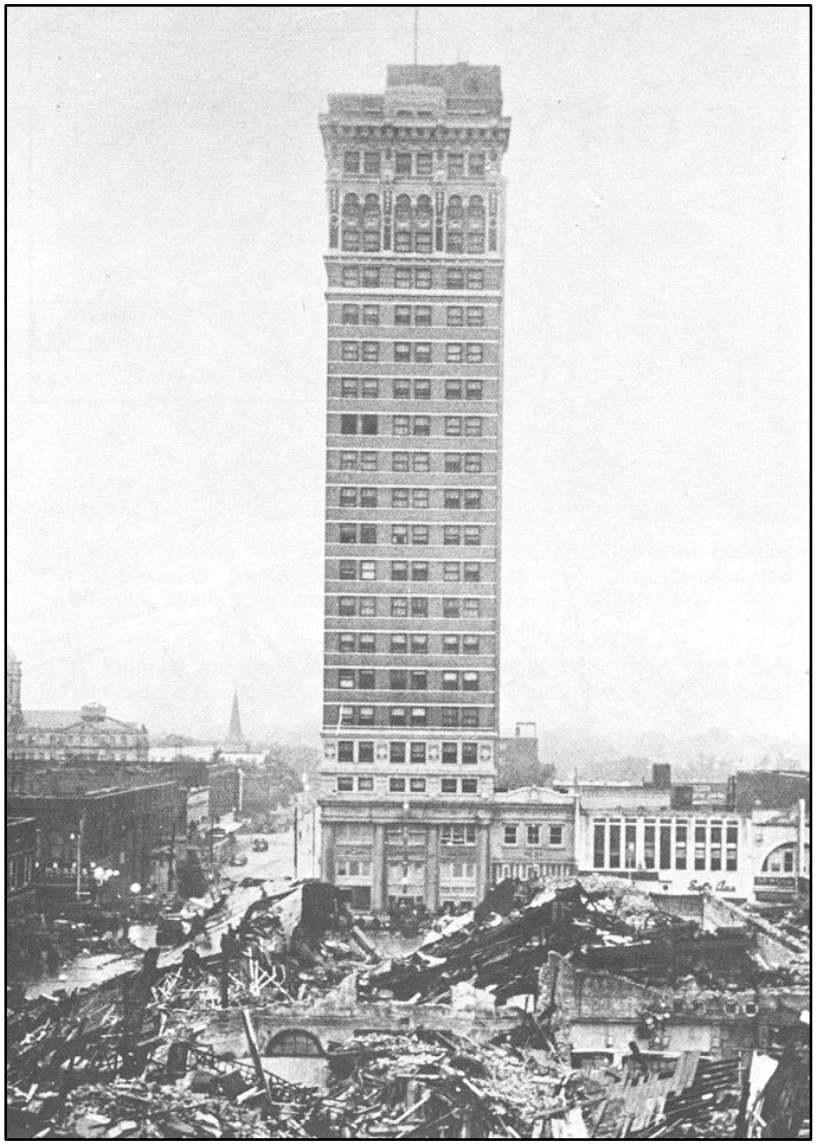


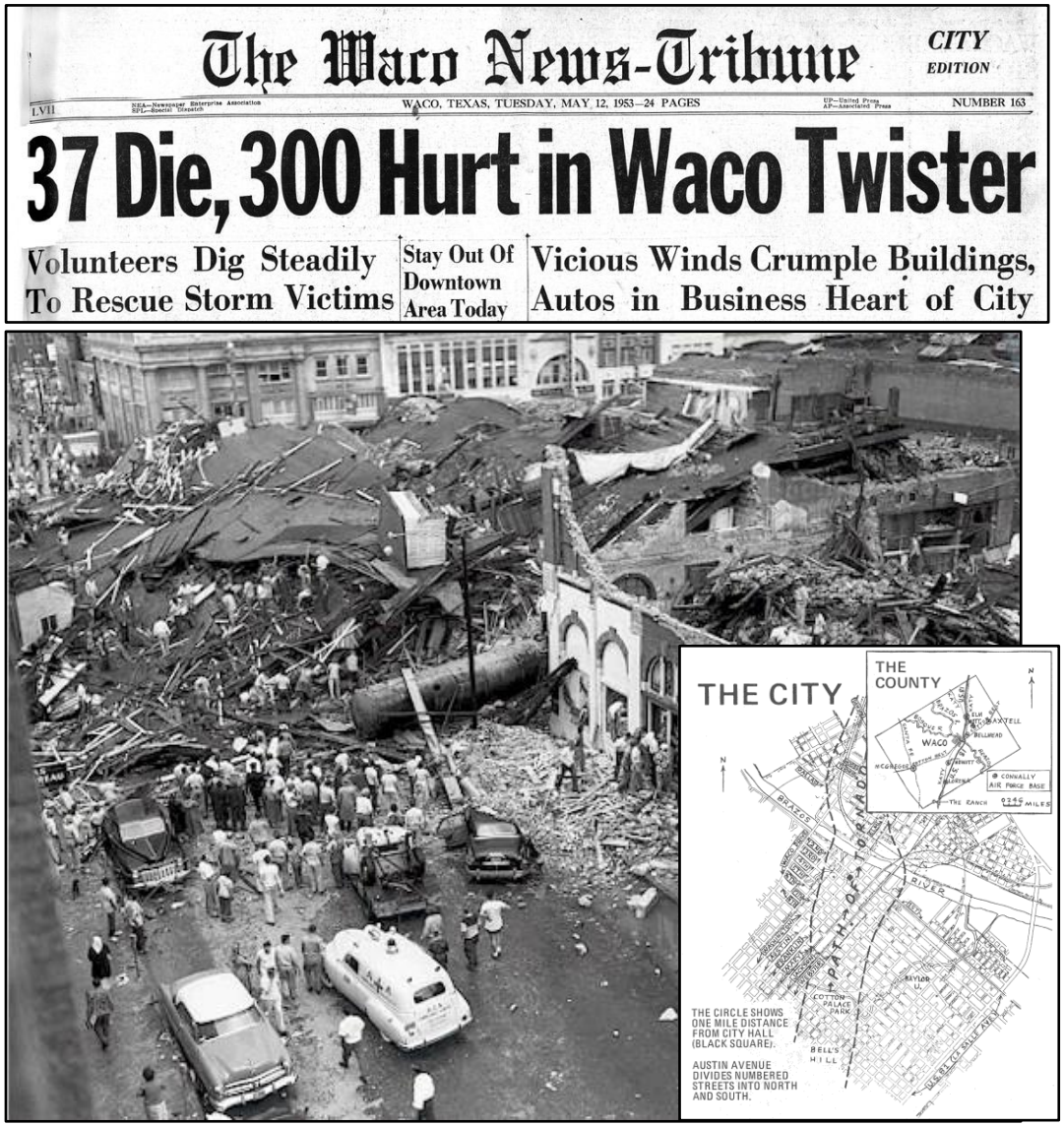
Xenia, OH (F5, 34 deaths, 1150+ inj.) & Brandenburg, KY (EF5, 31 deaths, 270+ inj.)

US Tornado Deaths per Million in Population



1953 - 519k: Waco + Flint + Worcester





The Waco News-Tribune — CITY EDITION

LVII — WACO, TEXAS, TUESDAY, MAY 12, 1953—24 PAGES — NUMBER 163

37 Die, 300 Hurt in Waco Twister

Volunteers Dig Steadily To Rescue Storm Victims

Stay Out Of Downtown Area Today

Vicious Winds Crumple Buildings, Autos in Business Heart of City

Waco, TX: 30+ fatalities in furniture store (F5, 114 fatalities, 597 injuries)

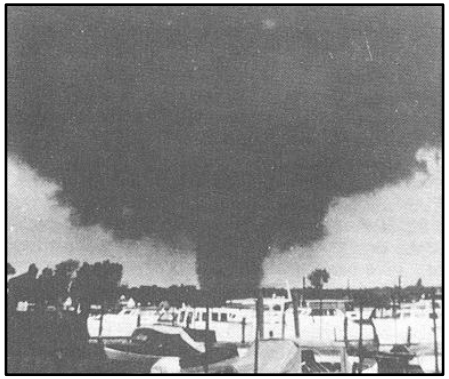
1953 - 519k: Waco + Flint + Worcester

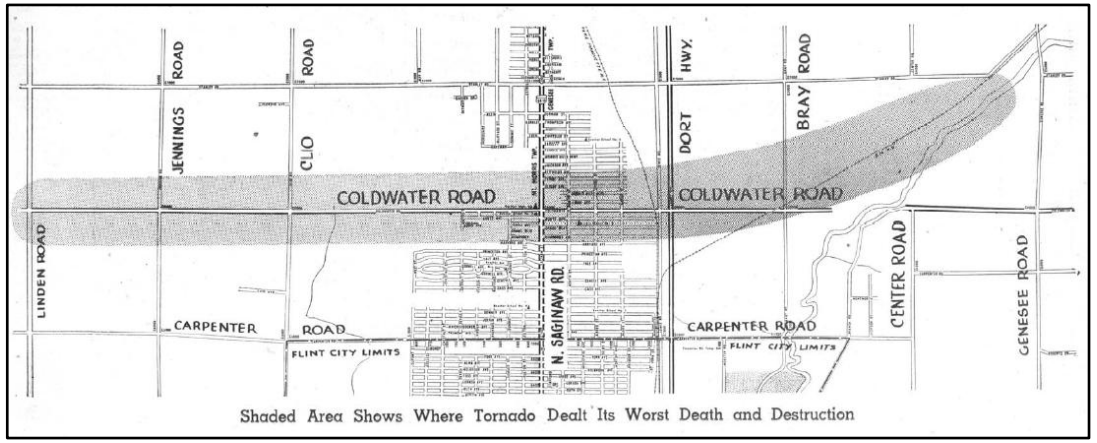

EXTRA The Flint Journal Eight Pages Tornado News EXTRA

Seventy-First Year Phone 4-7611 Flint, Michigan, Tuesday, June 9, 1953 Eight Pages Price Seven Cents

STORM DEAD NOW 109
650 JAM HOSPITALS

Ten Million Dollar Damage Estimate

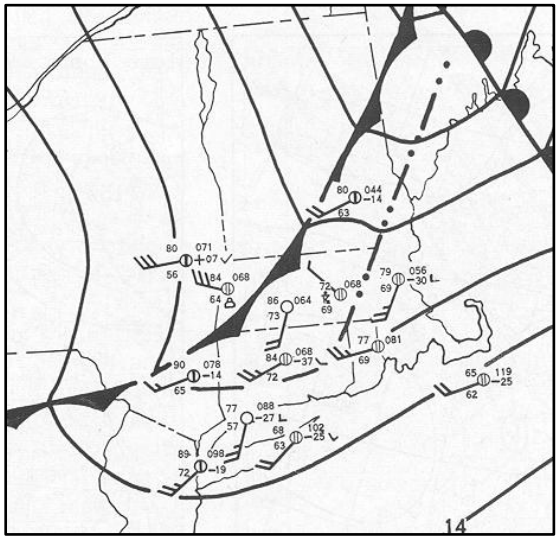


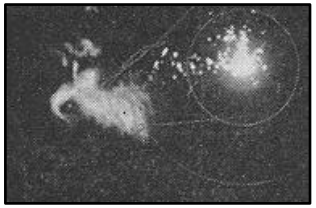


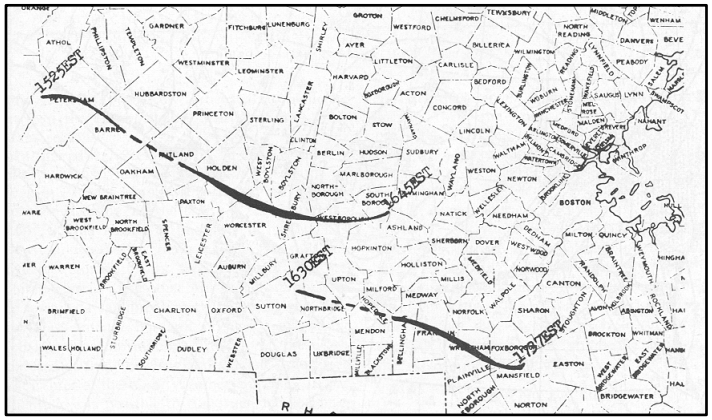
Shaded Area Shows Where Tornado Dealt Its Worst Death and Destruction

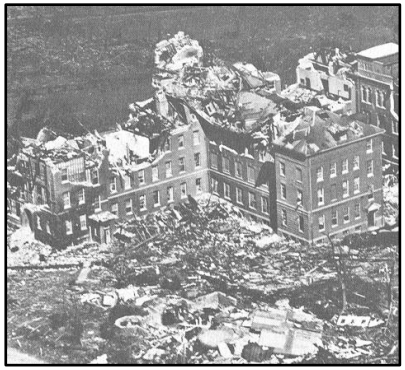
Flint, MI: 8:30pm, 300+ Homes Destroyed (F5, 116 fatalities, 844 injuries)

1953 - 519k: Waco + Flint + Worcester



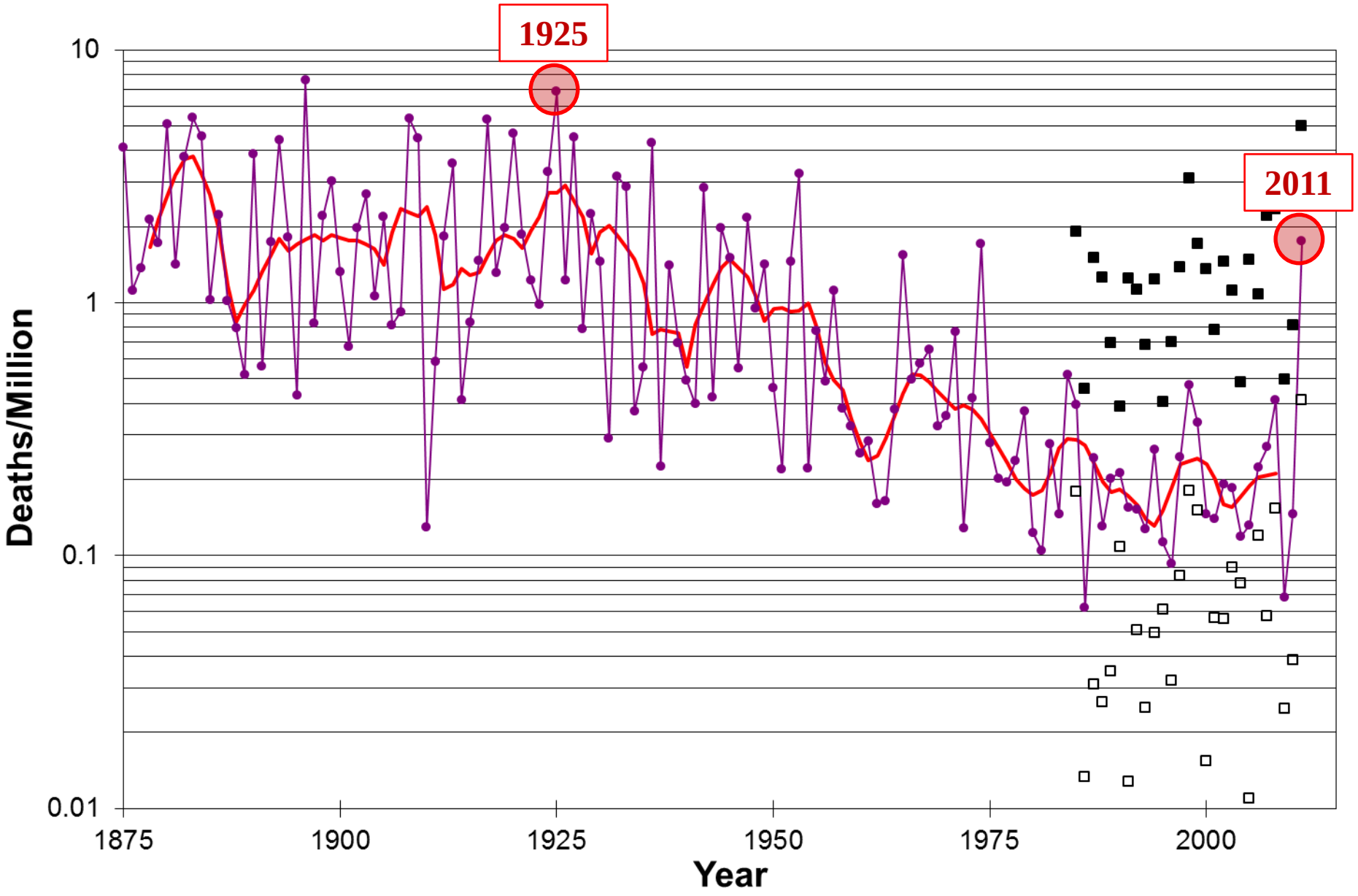




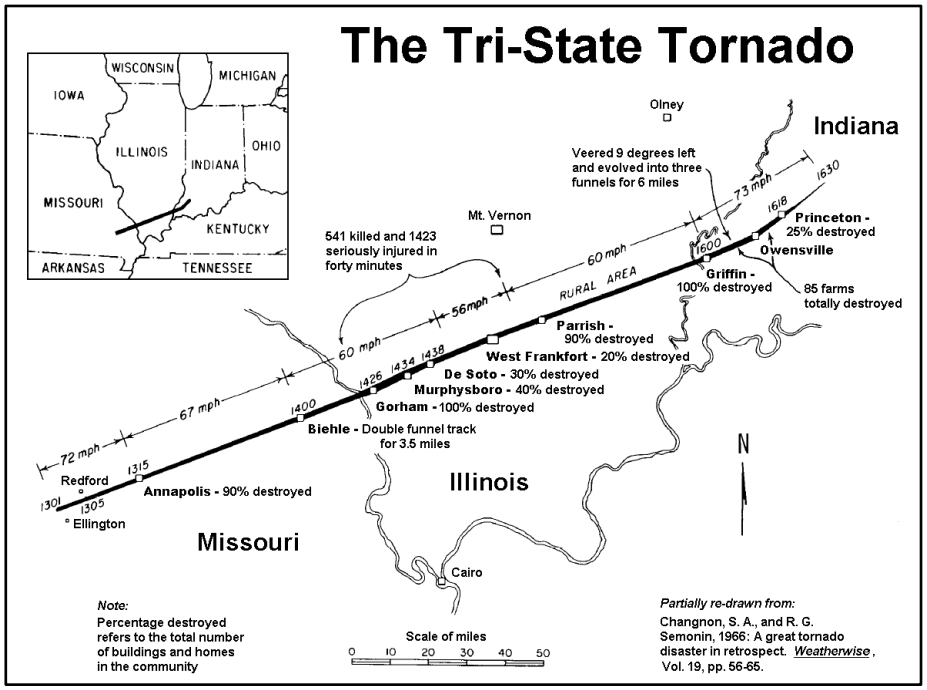


Worcester, MA (F4, 90 fatalities, 1288 injuries) 10,000 Homeless, 46 Mile Path

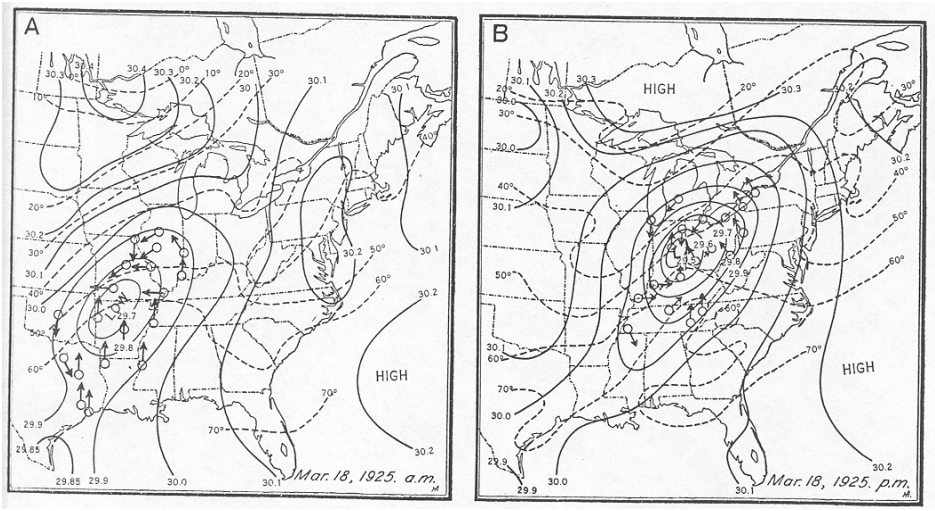
US Tornado Deaths per Million in Population



1925 - 794k: The Tri-State Tornado

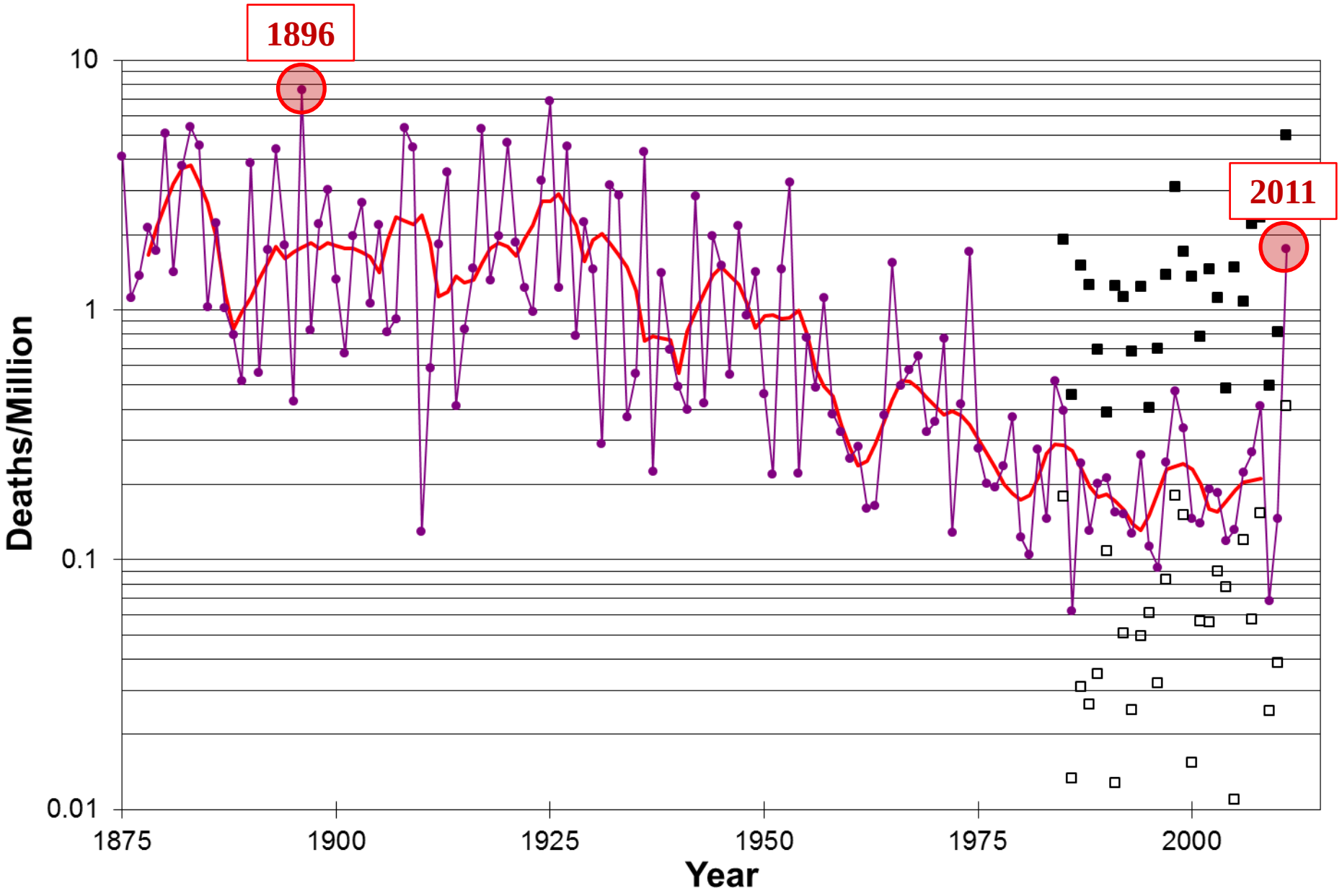


	F0	F1	F2	F3	F4	F5
9	0	0	2	4	2	1

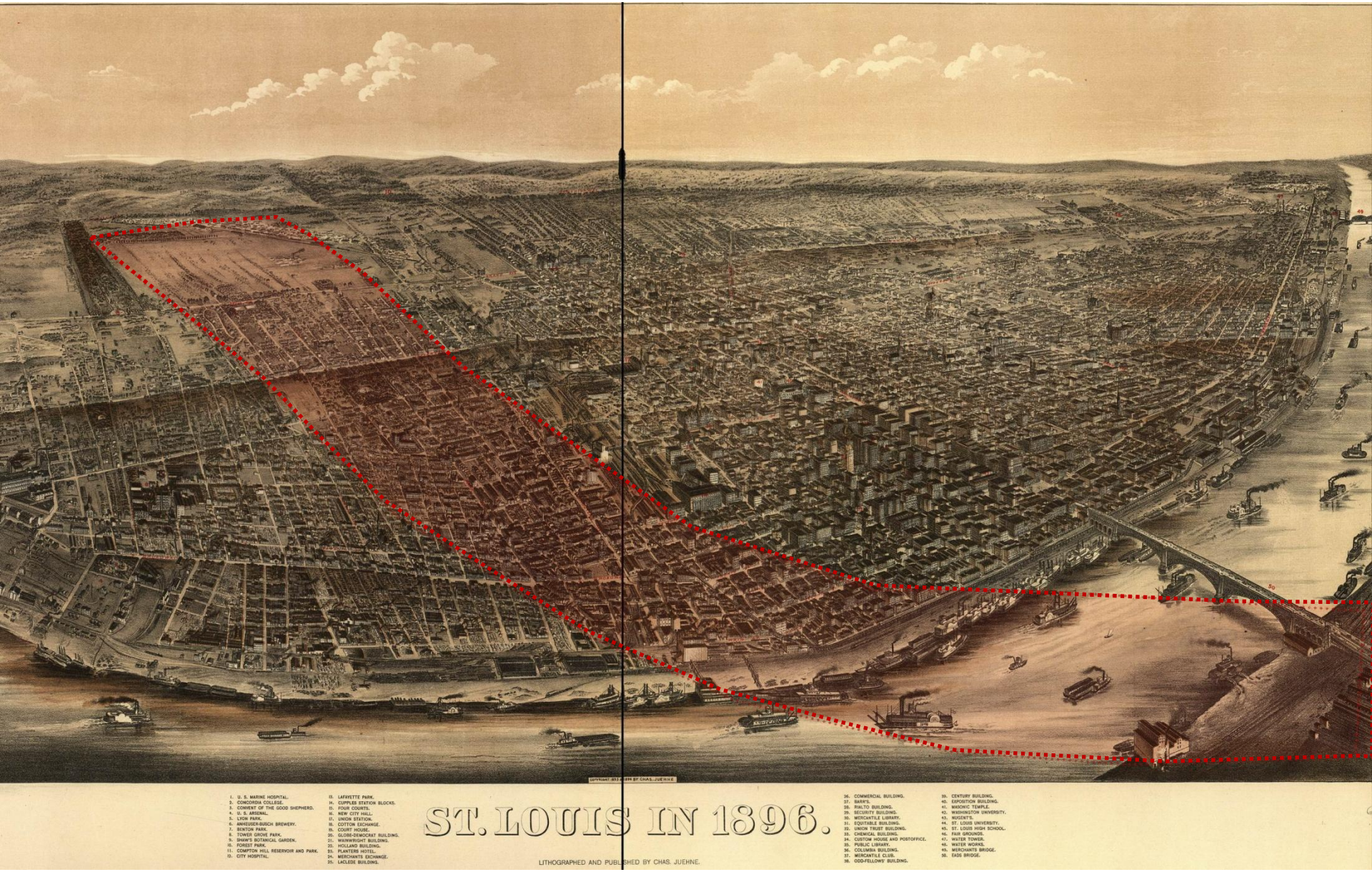


Tri State Tornado: ~ 1:00 pm – 4:30 pm; ~15000 homes destroyed (F5, 695 deaths, 2000+ inj.)

US Tornado Deaths per Million in Population



1896 - 537k: St. Louis



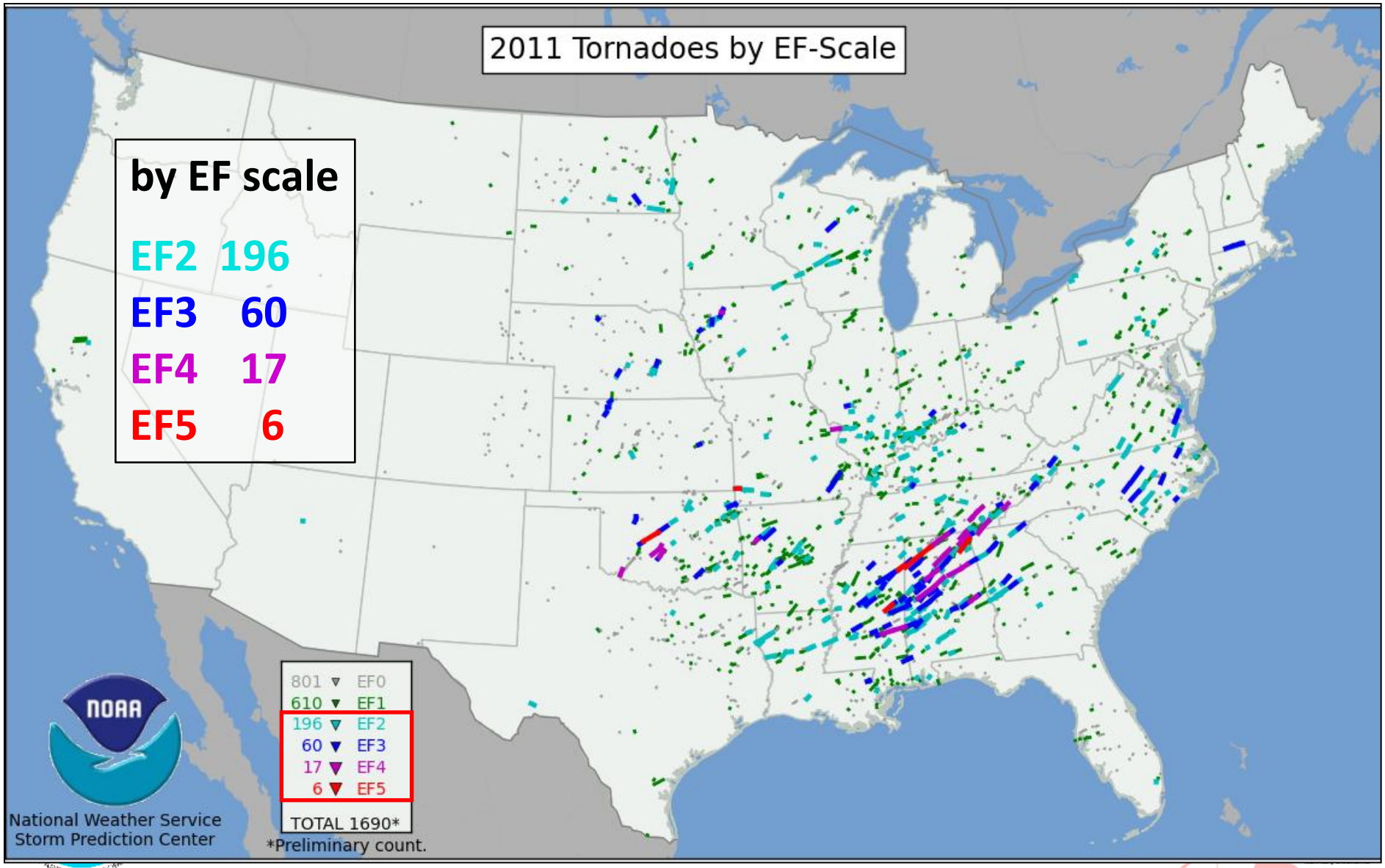
St. Louis Tornado: ~ 6:00 pm – 6:30 pm; $10,000,000 damage (F4, 255 deaths, 1000+ inj.)

Deadliest Tornado Years in US History

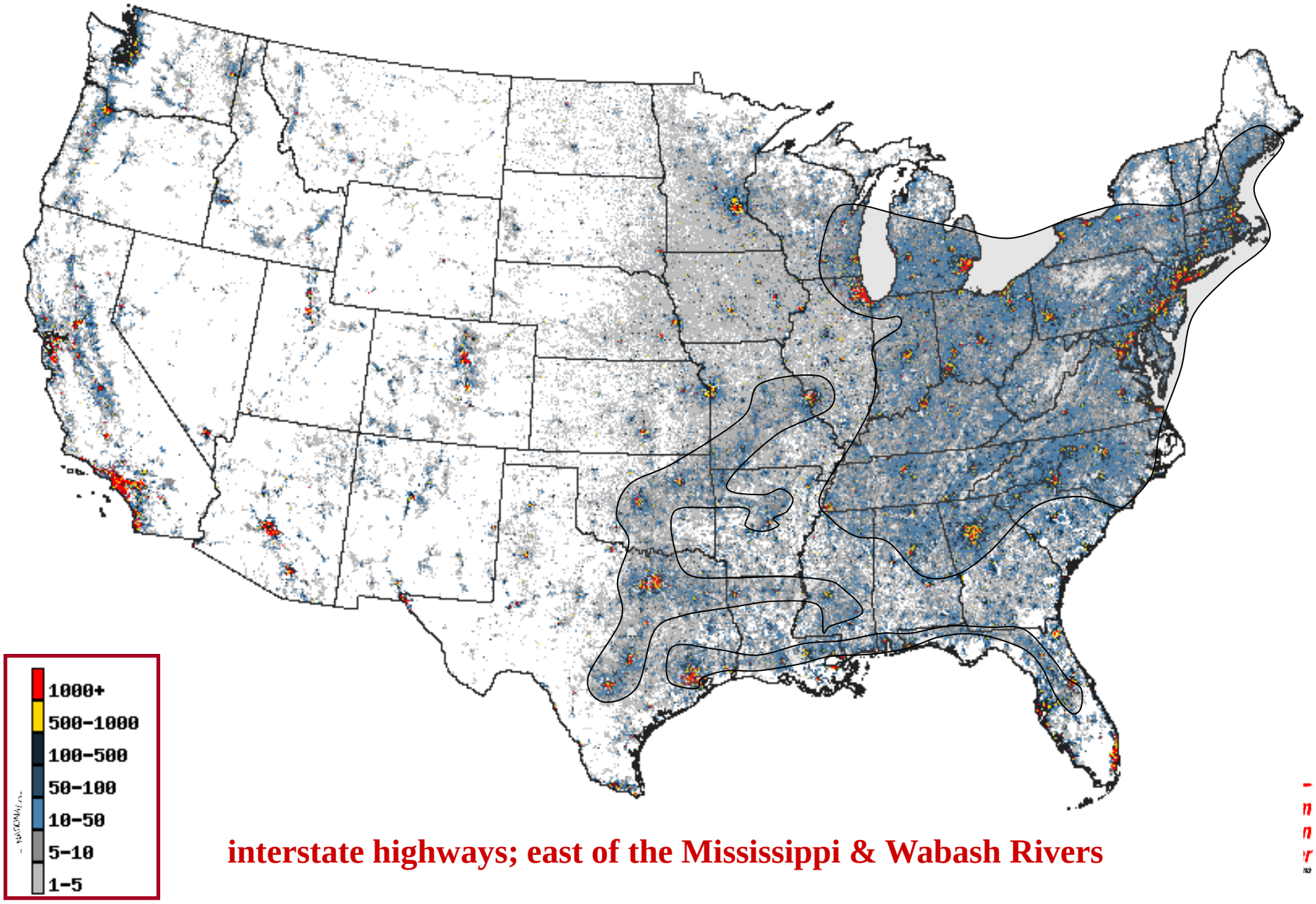
(Official NOAA-NWS Record: 1950 - present; Research by Grazulis: 1875-1949)

Year	Tornado Fatalities	Major Events
1925	**794**	**Tri-State Tornado**
1936	**552**	**Tupelo MS; Gainesville GA**
1917	**551**	**Mattoon IL; 25 May – 1 June Outbreak Sequence**
2011	**550**	**Joplin MO; 27 April (Tuscaloosa, AL)**
1927	540	St. Louis MO; Poplar Bluff MO, Rock Springs TX
1896	**537**	**St. Louis MO; Sherman, TX**
1953	**519**	**Flint MI; Worcester MA; Waco TX**
1920	499	Palm Sunday (Midwest - 20 April), Starkville MS
1908	477	Amite LA & Purvis MS; Natchez MS
1932	394	North Alabama (Georgia) Outbreak (21 March)
1974	***366***	***Super Outbreak (3 April)***

Tornadoes of 2011



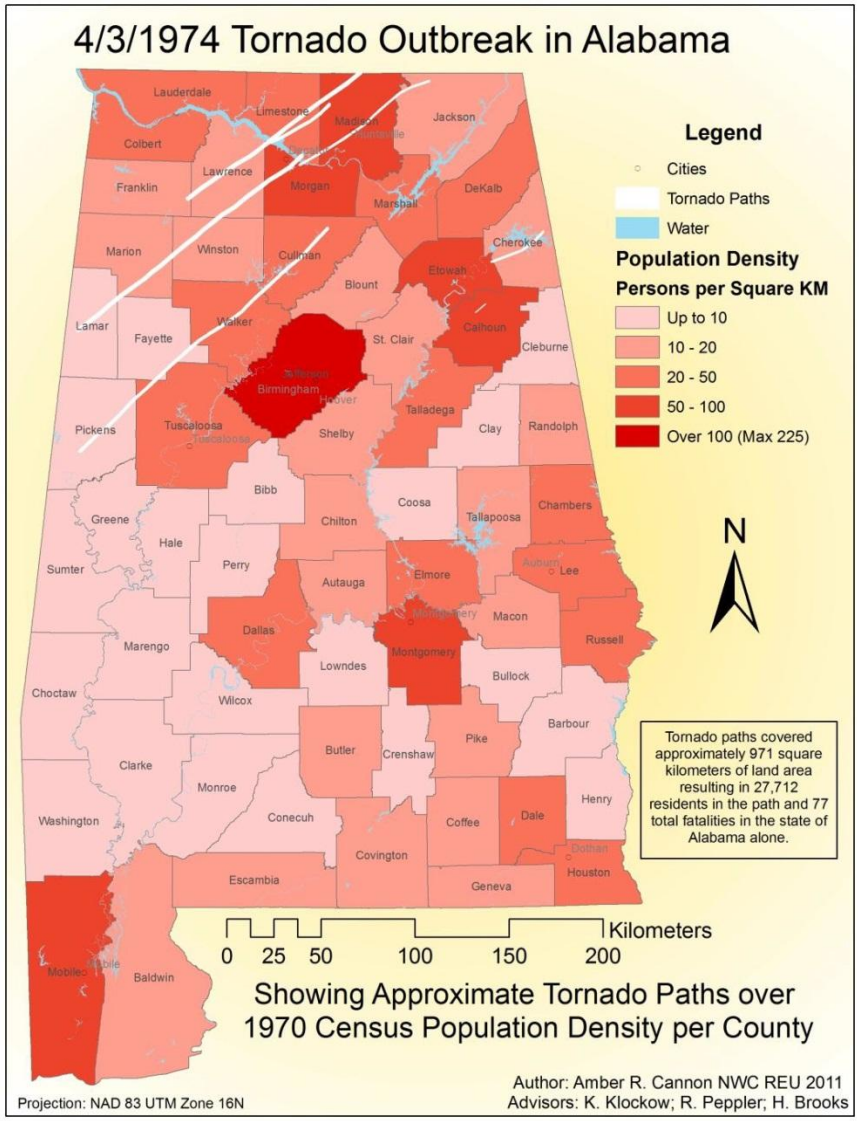
U.S. Population Density (persons km^{-2})

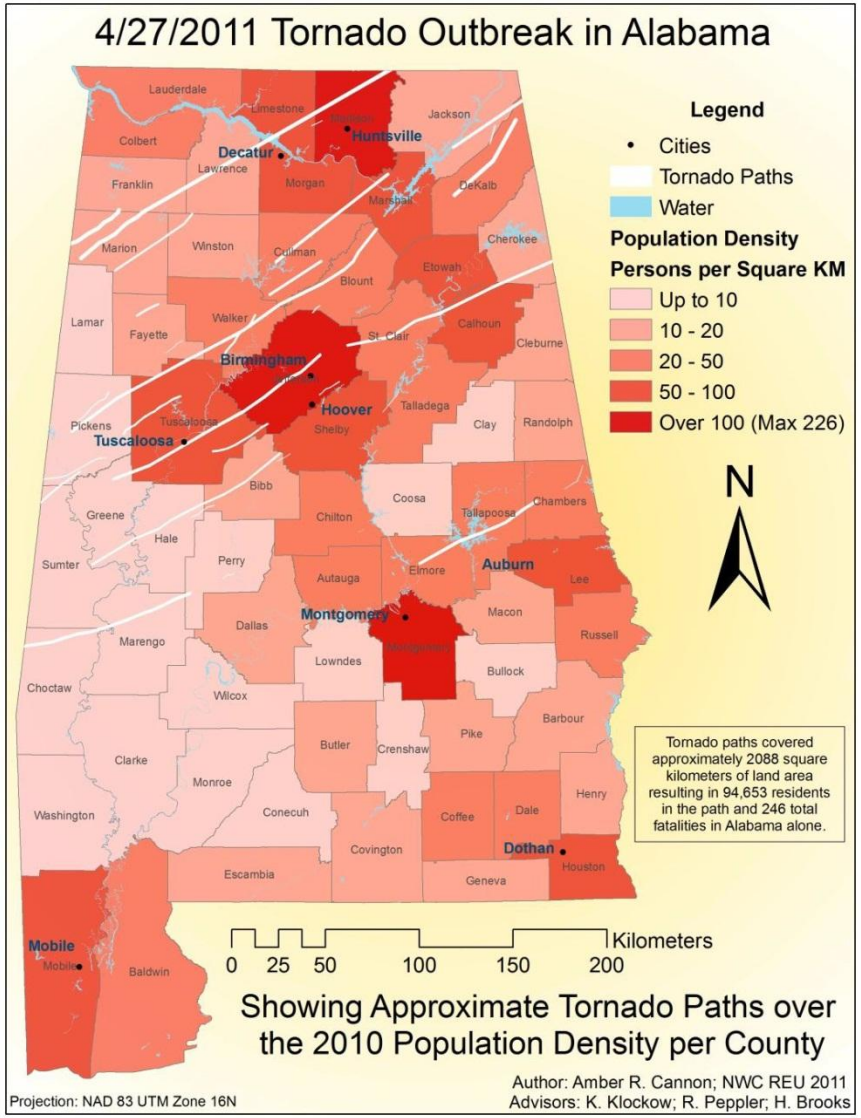


interstate highways; east of the Mississippi & Wabash Rivers

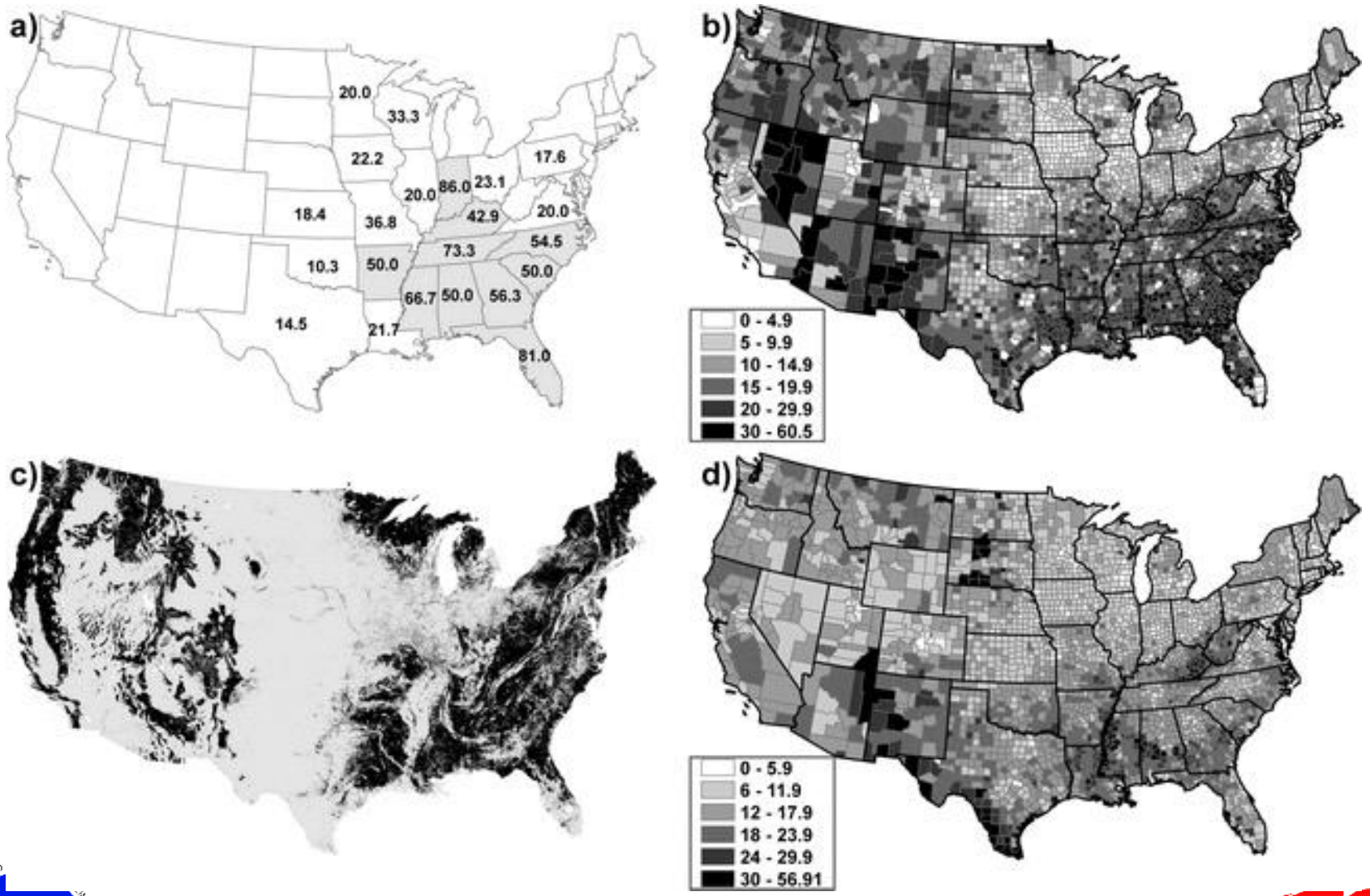
Comparing outbreaks in Alabama

6.5-16.5% Reduction in Fatalities



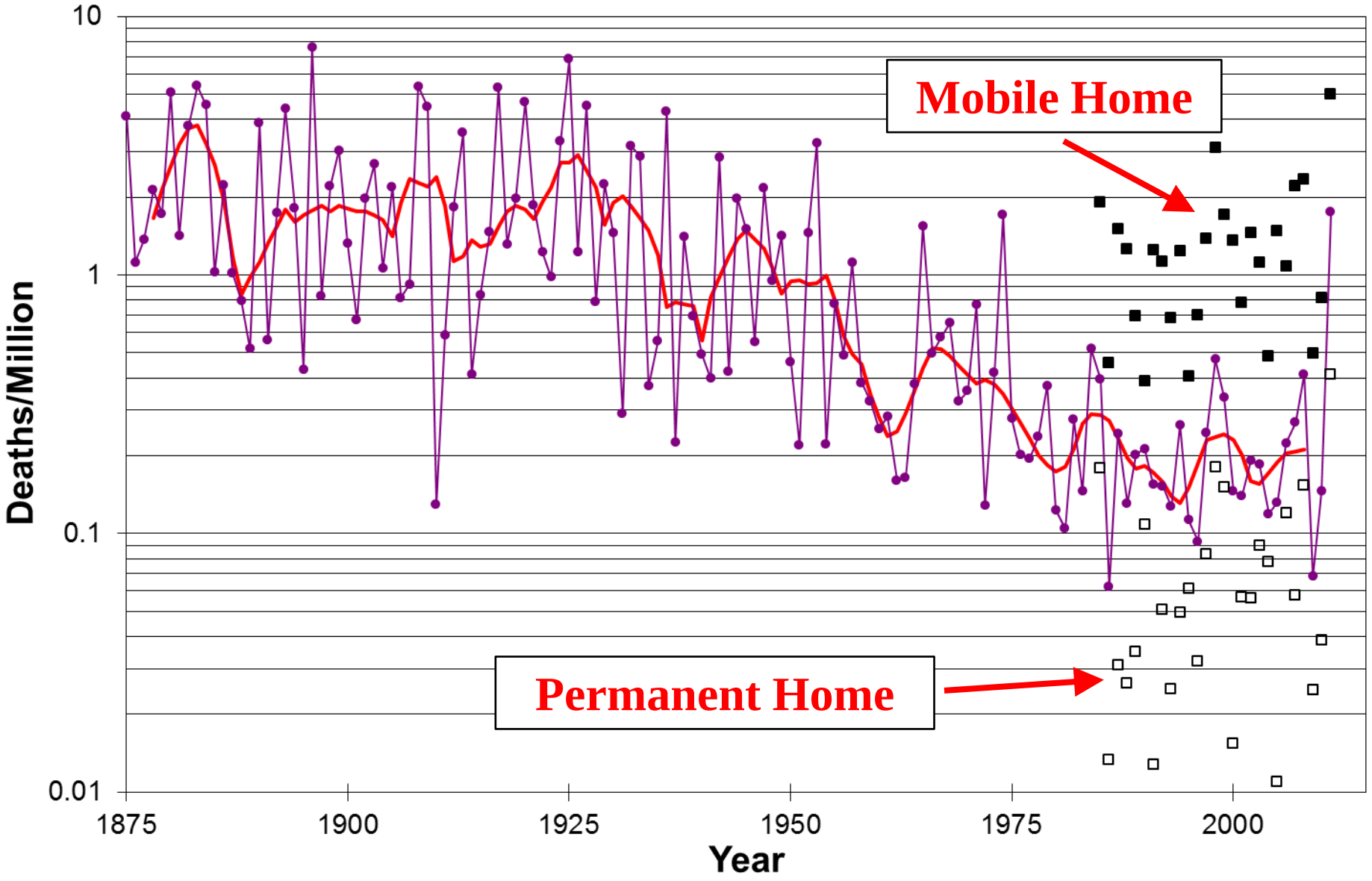


% Fatalities at Night, Mobile Homes, Trees & Poverty



Source: Ashley, *Weather & Forecasting*, 2007

US Tornado Deaths per Million in Population



APRIL 28, 2011, 2:28 PM ET

Mississippi Official Praises Tornado Warning System

Article | Video | Comments

Email | Print | Like 54 | Send | + More | Text

By Stephanie Simon

Mississippi authorities said the death toll was far lower than it might have been because of repeated, urgent warnings well in advance that nasty weather was coming.

"God bless the National Weather Service," said Greg Flynn, a spokesman for the Mississippi Emergency Management Agency, "because they gave us the heads up. While 32 deaths is a horrible number, it could have been a lot worse."

Mr. Flynn said he was gratified to see that so many residents in the tornadoes' paths took the warning seriously and took shelter.

"We got some really good lead time on the warnings," he said.

James Spann blasts number of false tornado warnings

Published: Wednesday, June 15, 2011, 6:30 AM Updated: Wednesday, June 15, 2011, 8:07 AM

+ View full size

TV meteorologist James Spann shown during a severe weather broadcast. (Screen capture image)

BIRMINGHAM, Alabama -- In the wake of the **April 27 tornadoes**, veteran television meteorologist James Spann is questioning whether too frequent tornado warnings are causing people to ignore them.

"I firmly believe apathy and complacency due to a high false alarm ratio over the years led to inaction in many cases that could have cost lives," Spann **wrote in a wide-ranging blog post** that has generated debate among weather watchers and fellow meteorologists.

In the post, the ABC 33/40 meteorologist criticizes what he considers a high false alarm rate by the National Weather Service in issuing tornado warnings, questions the utility of the siren alert system, and raises questions about practices in TV broadcasting

Weather Ready Nation: A Vital Conversation

December 13 - 15, 2011
Norman, OK

Goal: reduce the **loss of life** and **mitigate** the **social and economic impacts** of severe weather

http://www.joss.ucar.edu/events/2011/weather_ready/

Breakout Discussions

Community Groups of Expertise

- Senior Management
- Risk Reduction & Community Resilience
- Emergency Decision Makers
- Communications
- Physical Scientists
- Weather Operations
- Policy Specialists

Breakout Discussions

Cross-cut groups

Members of the seven community groups were then randomly assigned to seven cross-cut groups

Breakout Discussions

Cross-cut group key themes

1) Integrate meteorology and social science

2) Foster physical science improvements

3) Address dissemination issues

4) Ensure community resilience

5) Address warning performance issues

6) Improve forecast process

7) Increase standardization

8) Improve public education

9) Clarify hazard communications

10) Strengthen collaborations

11) Address human concerns

Breakout Discussions

Word Cloud Taken From Cross-Cut Group Notes

Breakout Discussions

Community Groups of Expertise

- Senior Management
- Risk Reduction & Community Resilience
- Emergency Decision Makers
- Communications
- Physical Scientists
- Weather Operations
- Policy Specialists

Community Priorities

Key Priorities – Emergency Decision Makers

- **Modernize NOAA Weather Radio (NWR)** using a public-private partnership to address the incorporation of polygon or other more refined geo-located warnings.
- Other topics that need to be addressed are:
  - *GPS integrated programmable radio and only activate for tornado warnings where radio is located, and*
  - *Increase coverage density/number of NWR transmitters to fill "dead areas."*
  - *Develop clear, consistent, and concise messages issued by weather service, emergency managers and the media and others in formats easily understood.*
- **Expand educational opportunities**, including beyond the classroom.
  - *Distill the existing knowledge base into useable format that supports broader educational needs,*
  - *Fund and use in-progress work and tools to implementation e.g. training modules,*
  - *Collaborate with the Natural Hazards Center as one approach to expanding linkage to application community, and*
  - *Identify and extend best practices nationally e.g., OK-First training modules.*

Community Priorities

Key Priorities – Risk Mitigation & Resilience

- **Conduct trans-disciplinary research** and other collaborative research efforts to evaluate success and failure stories and histories in risk management.
- **Examine functionally resilient and non-resilient communities** with a particular focus on why people survive (or sustain injuries) or not.
- **Improve** significantly the scientific **knowledge** and engineering models **to understand how buildings fail in tornadoes**, leading to better designs that can resist these forces.
- **Educate the public in terms of risk awareness and vulnerability.** Work with state education boards and develop vulnerability simulation to support classroom activities.
- **Develop an approach for resilient buildings both for existing and new construction.** Costs of structural enhancements for existing structures need to be explored and communities need to be aware of the tradeoffs.

Community Priorities

Key Priorities – Communication

- **Create Research/Resource Centers** in which social and physical scientists can work with forecasters and/or forecast users to ensure successful communication of extreme weather threats. These Centers would focus on fundamental social science research issues and on transitioning social science research into operational practice.
- **Review and improve warning dissemination strategies and technologies to increase effectiveness.** *The population is segmented:* by age, income, schedules, technology awareness and access. This creates different vulnerabilities and requires multiple communication strategies.
- **Study the false alarm issue and develop/implement strategies, which increase public responsiveness to warnings.** The issue of false alarm needs to be addressed. There are numerous issues, including perceptions of false alarms. As the science of prediction improves, the issue of false alarm will obviously change but in ways that may not be obvious.

Community Priorities

Key Themes – Specific Ideas

- **Integrate strongly social and physical science into the future end-to-end extreme weather forecast and warning process – from research to operations.**
  - *All breakout groups indicated public understanding of warnings and their perceptions of risk are important gaps and recommended early and more effective integration of social science in warning policy, plans, and programs. The issue of perception of risk may be especially important.*

- **Review carefully the issue of warning false alarms**
  - *to determine physical science improvements and other strategies that can be used to reduce false alarms without decreasing threat detection and warning lead-time.*
  - *Breakout groups expressed concern that public responsiveness is negatively affected by a perception that warnings are overblown.*

Community Priorities

Key Themes – Specific Ideas

- **Assess and update warning dissemination strategy.**
  - *New wireless technologies afford a great opportunity to improve the speed and effectiveness of severe weather warning. At the same time, the strategy must not leave behind segments of the population who do not use or have access to more modern technologies.*

- **Advance physical modeling of severe weather to provide improved lead-time, accuracy and precision**
  - *… necessary to facilitate tornado warnings based on weather forecast model output ("Warn on Forecast"). Today's critical dependence on weather radar observations for warning the public limits the advance warning in most cases to approximately 15-20 minutes.*

- **Build coalitions with corporate America.**
  - *Such coalitions could enhance significantly the effectiveness of government actions and thereby have great potential to make a difference.*

Community Priorities

Key Themes – Specific Ideas

- **Improve outreach and education**
  - *… to supported agencies and groups: Federal Emergency Management Agency (FEMA), emergency managers, threatened communities. Breakout groups agreed that preparation requires credible communication of threat, which leads to proactively planning on the part of communities and individuals. There is also a need for all to better understand the scientific certainty and uncertainty inherent in extreme weather forecasting and warning.*

- **Evolve the National Weather Service (NWS) Assessment following major severe weather outbreaks**
  - *… into one more like the assessments of the National Transportation Safety Board (NTSB) following major transportation disasters. Increased participation and visibility would trigger broader national action to go beyond simply living with the personal and economic impacts of extreme weather.*

Continuing the Conversation

Complete & Current Meetings and Discussions

1) **Weather Ready Nation - A Vital Conversation** (Norman, OK)

- *Completed 13-15 December 2011 :* With over 175 participants from a diverse cross section of key partners and stakeholders.

2) **AMS Town Hall** report on Norman workshop outcomes (New Orleans, LA)

- *Completed 23 January 2012:* More than 300 community participants, and comments and insights from the Town Hall discussion are integrated in this report.

3) **National Severe Weather Workshop in Norman** (Norman, OK)

- 1-3 March 2012 http://www.norman.noaa.gov/nsww/agenda/

Continuing the Conversation

Upcoming Meetings and Discussions

4) **2012 National Emergency Management Association (NEMA) Mid-Year Conference** titled *"Extreme Weather – Is it the New Norm"* (Alexandria, VA): *28 March 2012*

5) **AMS Washington Forum** titled "Towards a Weather, Weather, and Climate Ready Nation" to describe upcoming WRN actions to the community: 10-12 April 2012

- http://www.ametsoc.org/meet/fainst/2012washingtonforum.html

6) **Weather Ready Nation: Imperatives for Severe Weather Research** (Birmingham, AL): 23-26 April 2012

7) **"Working Together Today to Save Lives Tomorrow"** – Washington D.C. May 2012

Continuing the Conversation

Upcoming Meetings and Discussions

8) **Annual Natural Hazards Research and Applications Workshop** (Broomfield, CO): 14-17 July 2012

9) In *Planning:* **National Weather Association (NWA)** - Social Sciences and the Weather Ready Nation: Collaboration Leading to Impact Based Decision Support Services (Madison, WI): *6-11 October 2012*

10) In *Planning:* **2012 International Association of Emergency Managers** (IAEM) Annual Conference (Orlando, FL): 26 Oct-1 Nov, 2012

11) In *Planning:* **2013 AMS Annual Meeting** (Austin, TX) *6-10 January 2013*

- Include strong local chapter involvement in WRN communication and engagement

12) *In Planning:* 2013 AMS Annual Meeting - Student Conference

www.spc.noaa.gov

Russell.Schneider@noaa.gov

Today's US Severe Weather Outlook